

35 mm Dipole End Fields
and
Optimum Positioning of the 3-pole Wiggler
(efficient use of end space)

Ramesh Gupta
Superconducting Magnet Division

Topics Covered

- Analysis of the Present Ends
- How to make ends more efficient

Also more efficient use of the space at the magnet ends

- Future topics (not this presentation)

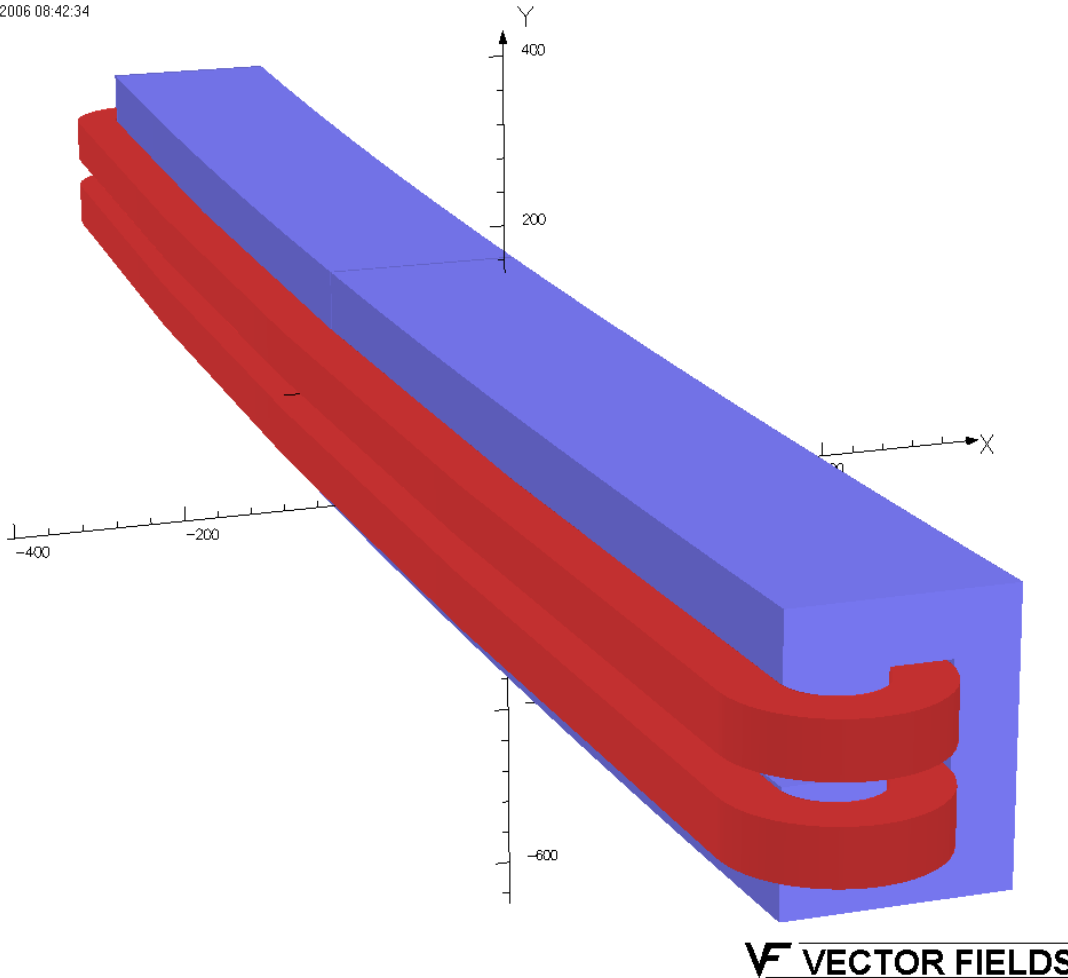
Dipole and 3-pole wiggler modeled together for optimum positioning of the three pole wiggler

Previous LS2/NSLS presentations can be found at:

<http://www.bnl.gov/magnets/Staff/Gupta/Talks/NSLS2-internal>

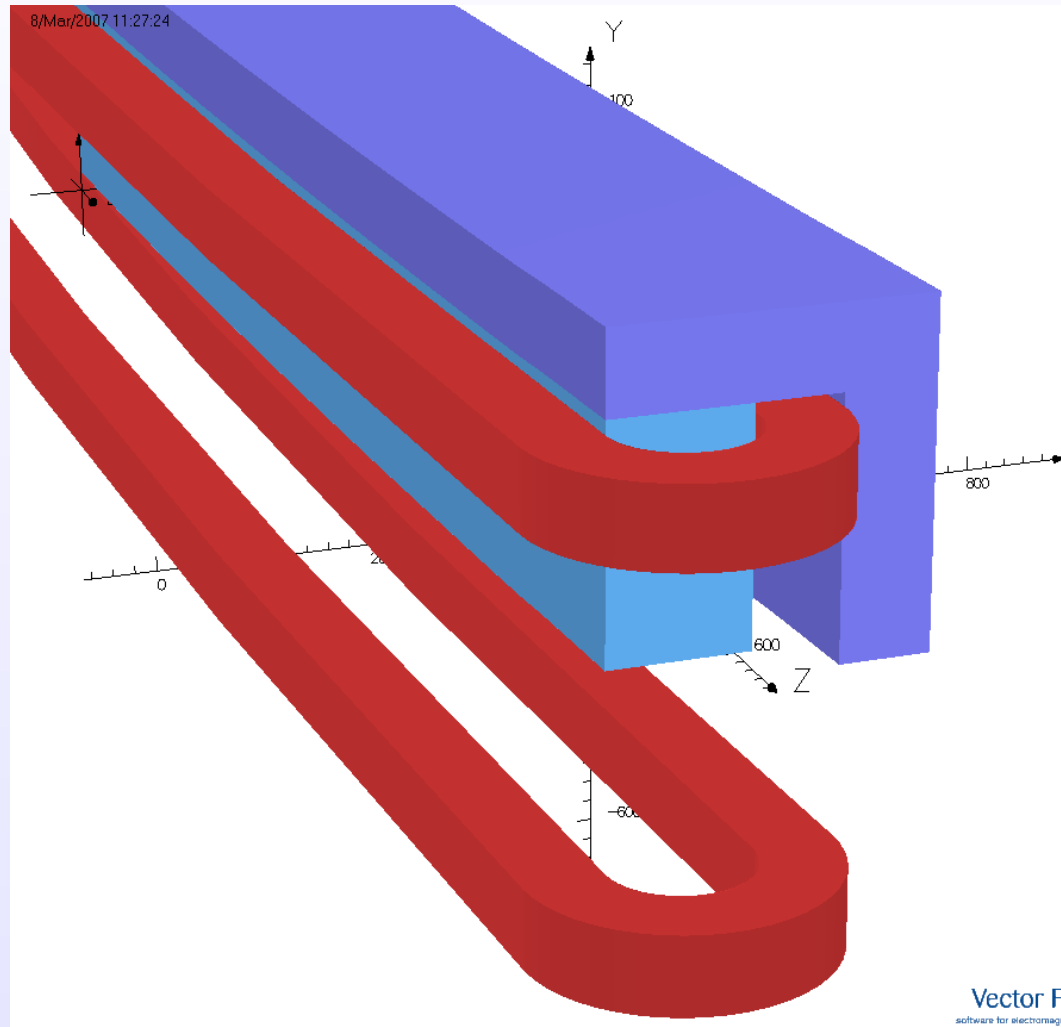
Present Design of the Yoke

25/Jul/2006 08:42:34



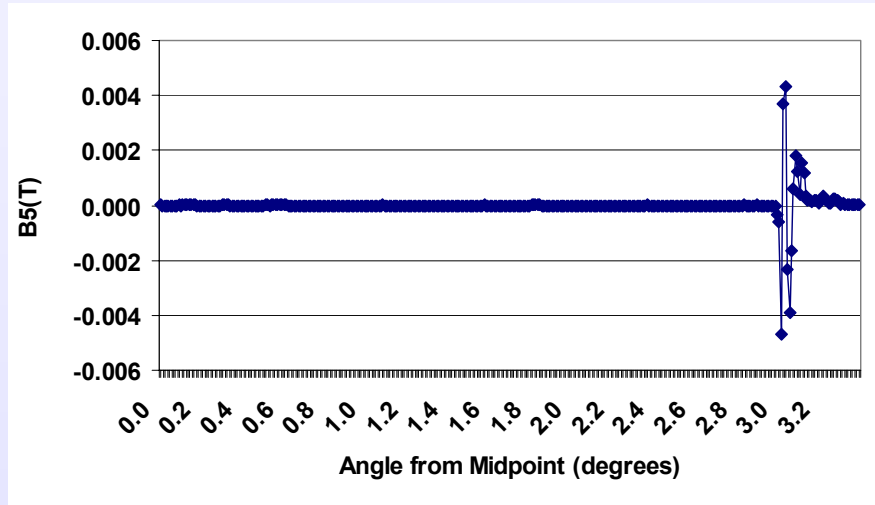
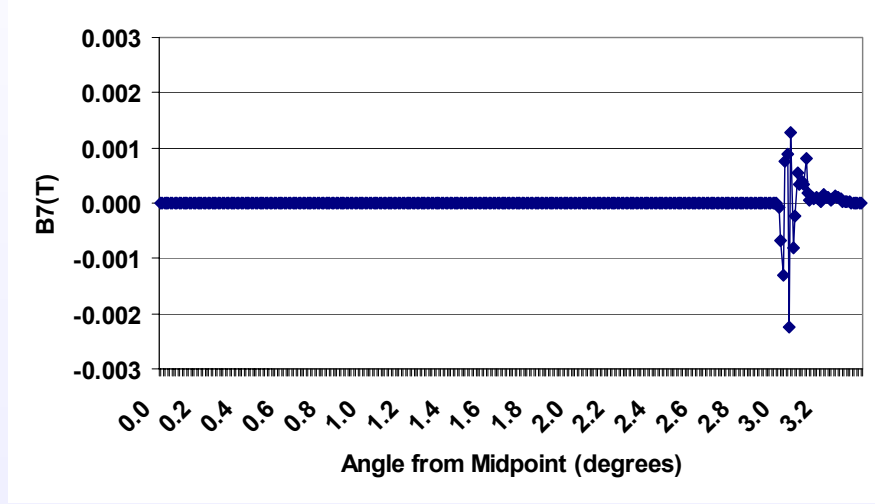
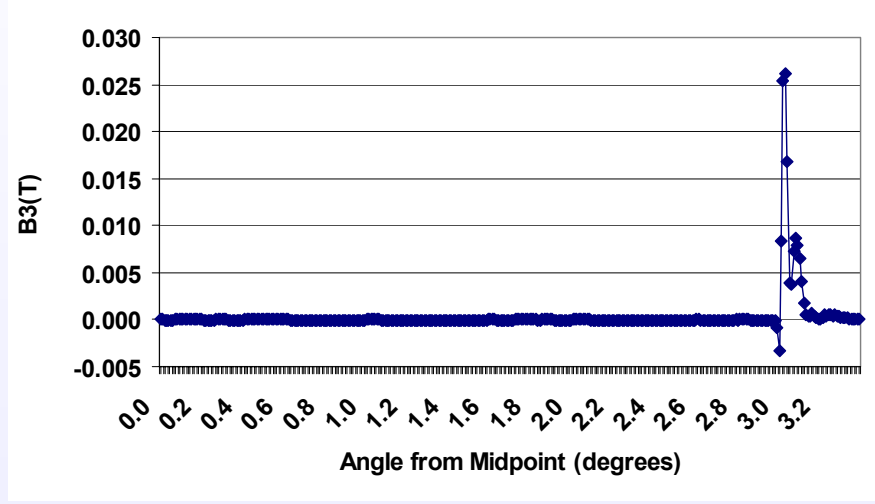
- Two iron end faces are parallel to each other.
- Thus they are not perpendicular to the beam entering and exiting the magnet. Thus one would expect end focusing.
- If desired, we can make sector magnets where end faces are perpendicular to the beam.

Present Design of the Coil Ends



- Mechanical design of the coil assumes circular ends.
- The magnetic model conforms to this.
- However, coils can be made racetrack to minimize end space (see a later transparency for more details)

Axial Variation of Field Harmonics



Integral harmonics at 10 mm radius

Harmonics at 10 mm radius
(first harmonic is name n=1)

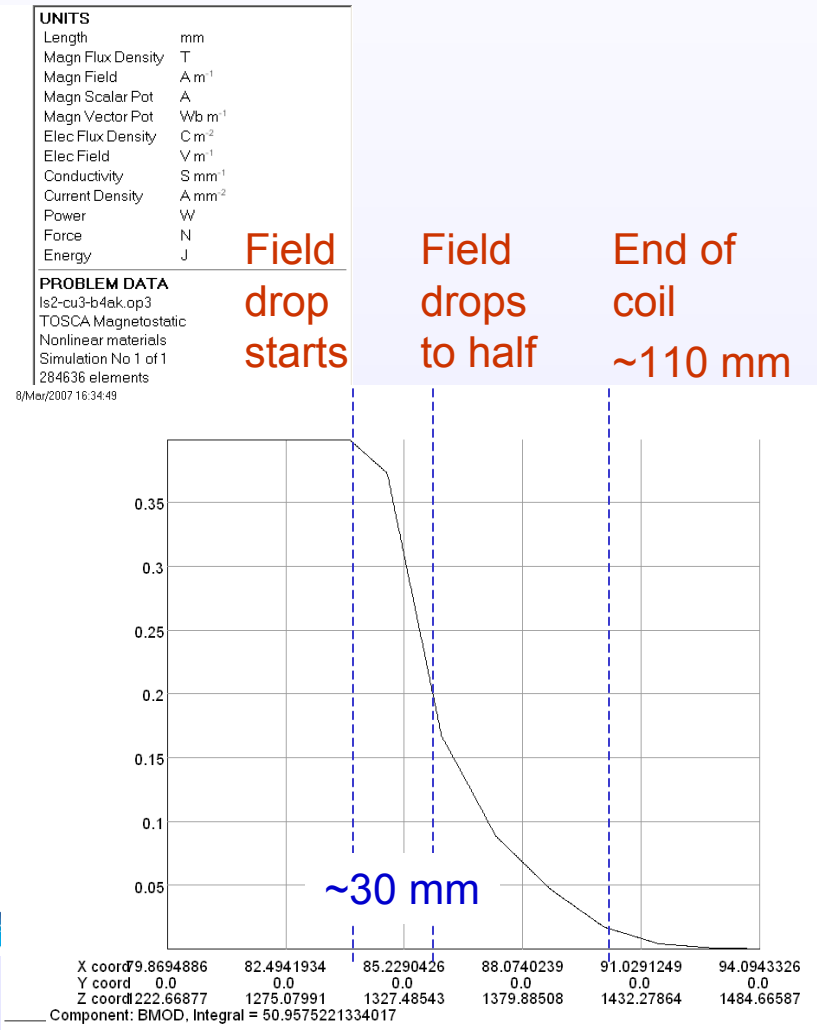
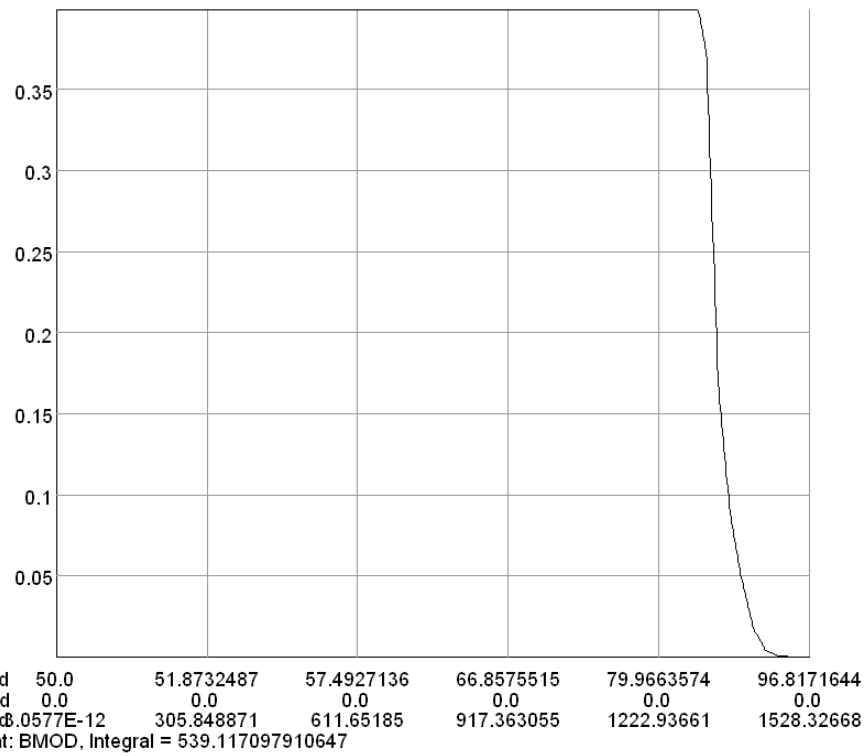
	n	$B_n(T.m)$
Dipole	1	0.53758
Sextupole	3	5.20E-04
Decapole	5	1.51E-05
	7	6.59E-06
	9	6.85E-06

(in half magnet)

These calculations are good for accuracy desired in end regions (2-d calculations are more accurate in describing body fields).

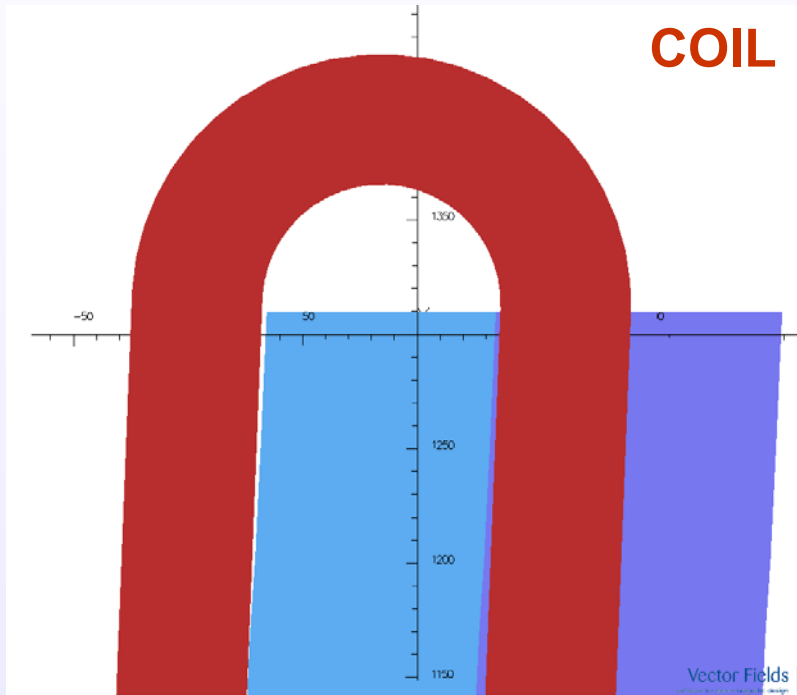
Axial Variation of the Field Along the Beam Axis (magnet is curved)

7/Mar/2007 10:05:27

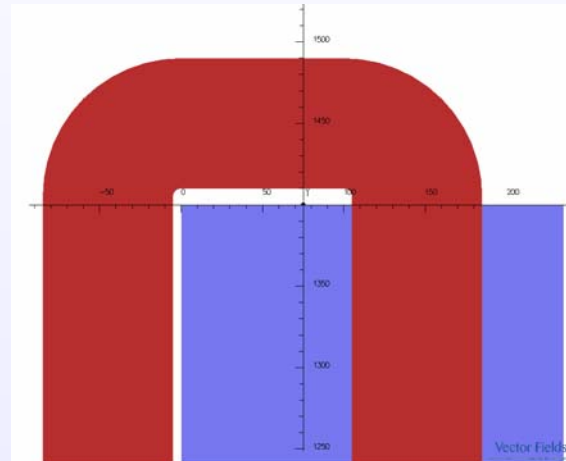


Analysis of the present design

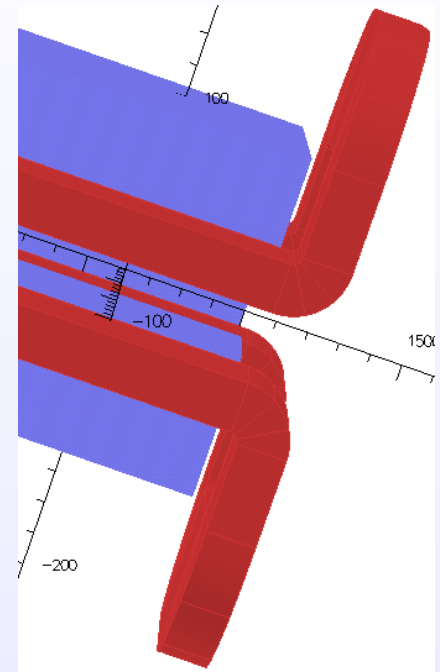
Different Types of Coil Ends



Model of an end in an earlier design



Race track coil ends are less wasteful (space-wise)



Saddle coils

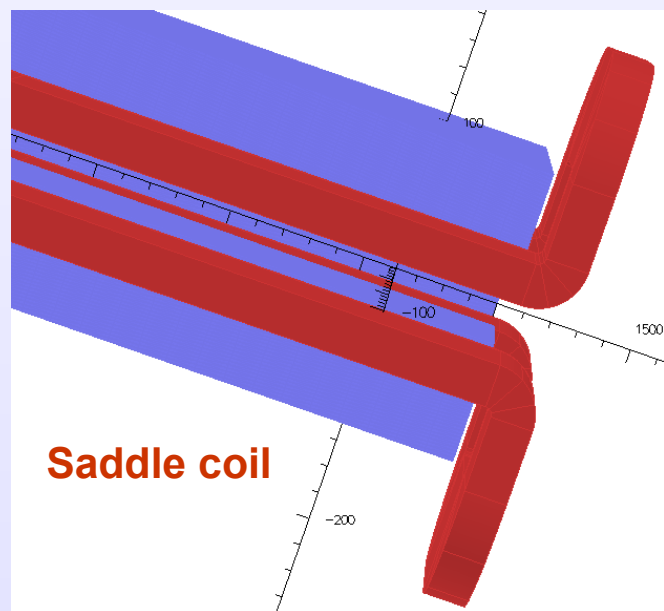
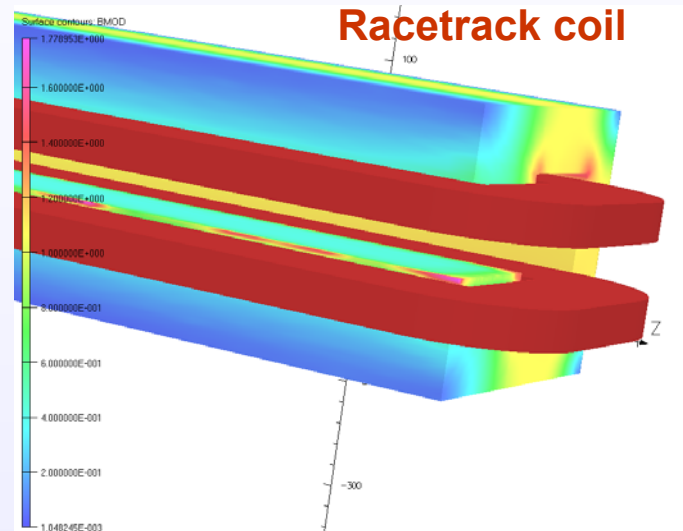
Model of the current ends
(circular ends takes too much space
– not productive in creating field)

However, the space in coil end region is still not used in creating field (since there is no iron).

Next few slides:

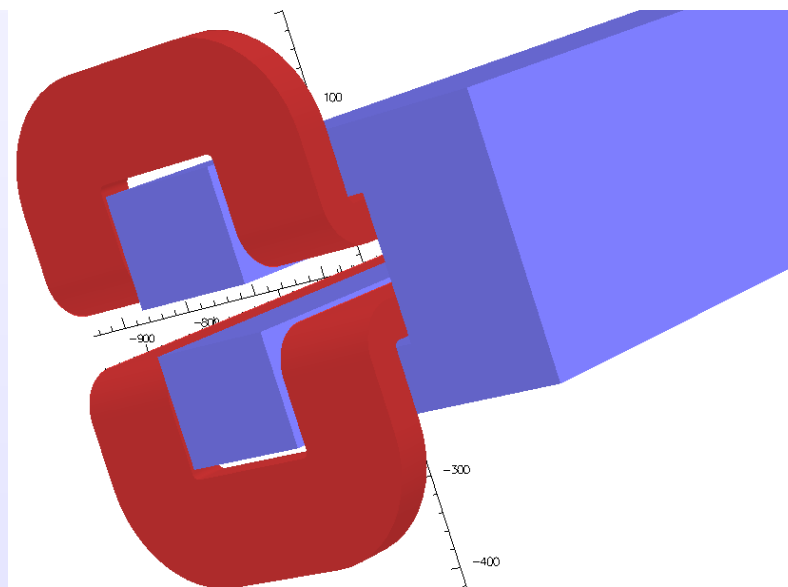
How to make a productive use of this space!

Extended Pole Piece to Eliminate Loss in Magnetic Length Due to Coil Ends



An investigation to see if magnetic length can be determined by pole only and loss in length due to coil ends can be freed-up for other purpose.

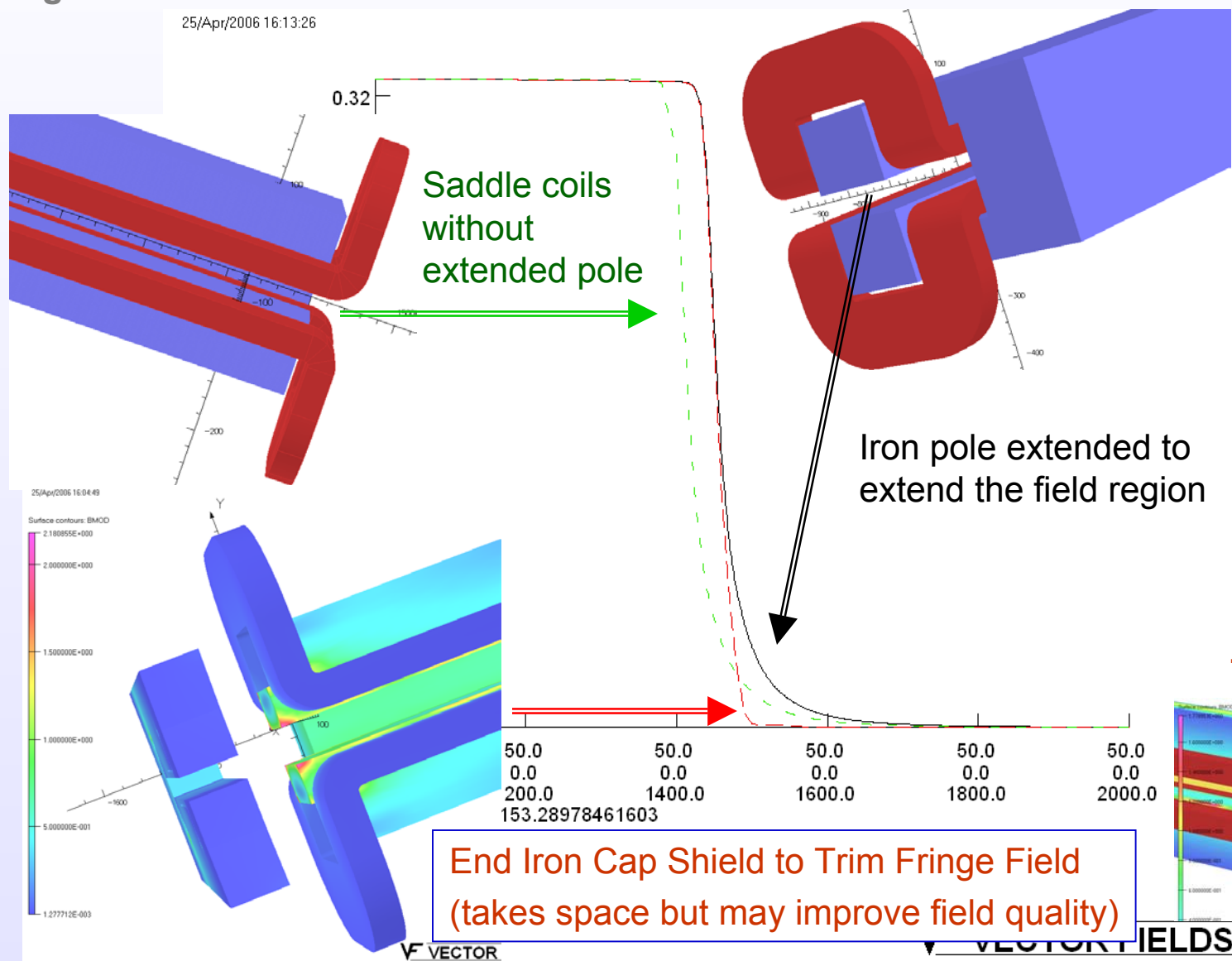
Likely to be more beneficial in low field magnet (such as this) where iron defines the field shape.



Saddle coil with extended pole

Saddle Coil Ends Further Enhanced To Allow More Space In Machine

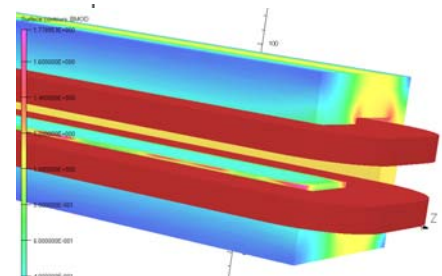
25/Apr/2006 16:13:26



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA	
Is2-cu-e1c1.op3	
TOSCA Magnetostatic	
Non-linear materials	
Simulation No 1 of 1	
2901376 elements	
490981 nodes	
1 conductor	
Nodally interpolated fields	
Reflection in XY plane (Z field=0)	
Reflection in ZX plane (Z+X fields=0)	

**Regular iron
Racetrack coils
(not included in
this comparison)**

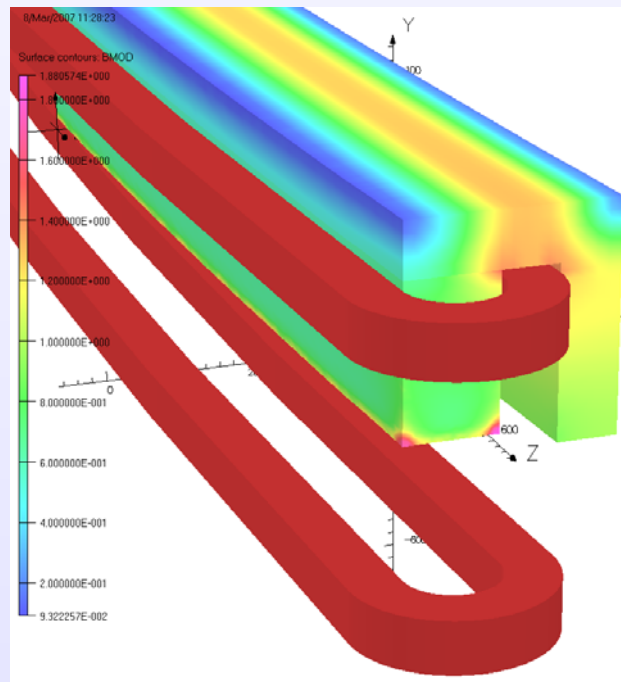


**End Iron Cap Shield to Trim Fringe Field
(takes space but may improve field quality)**

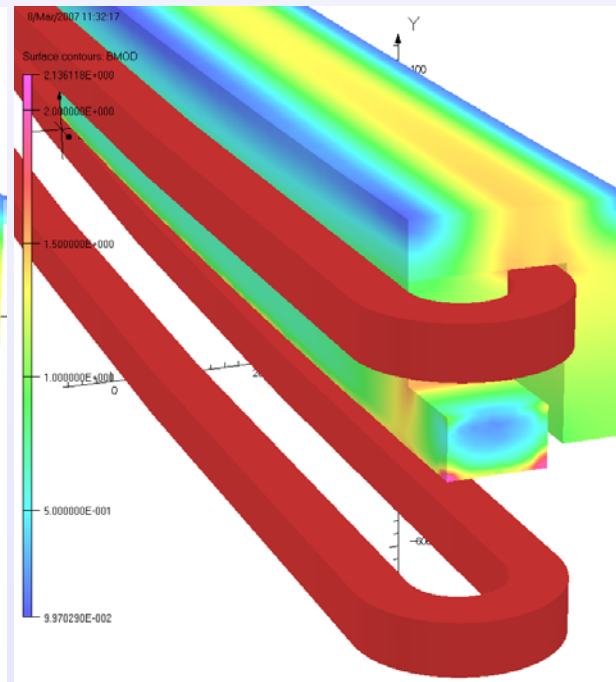
Recovering Lost Space in Racetrack Coil Ends By Extending Pole

With some adjustments, one can get similar gains in racetrack coils too.

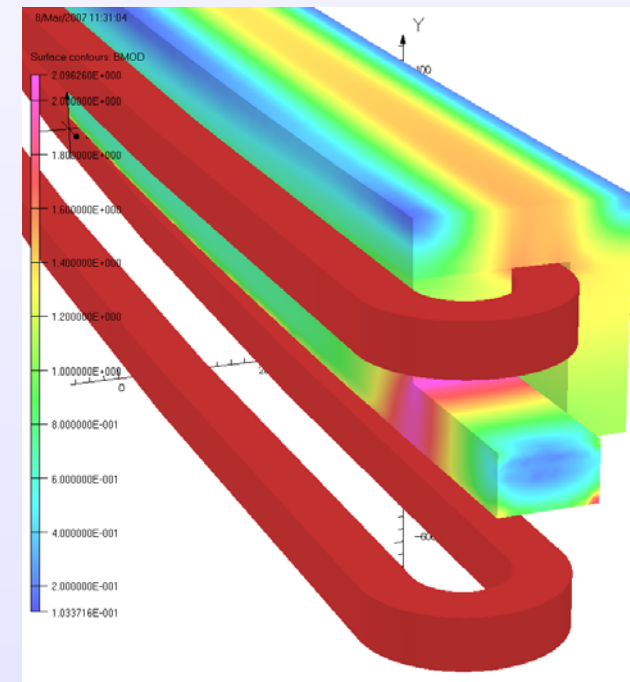
Space freed-up (available for other purpose) is ~15+ cm between two magnet ends. (Note: we are partly taking advantage of low field in poles).



Present Design

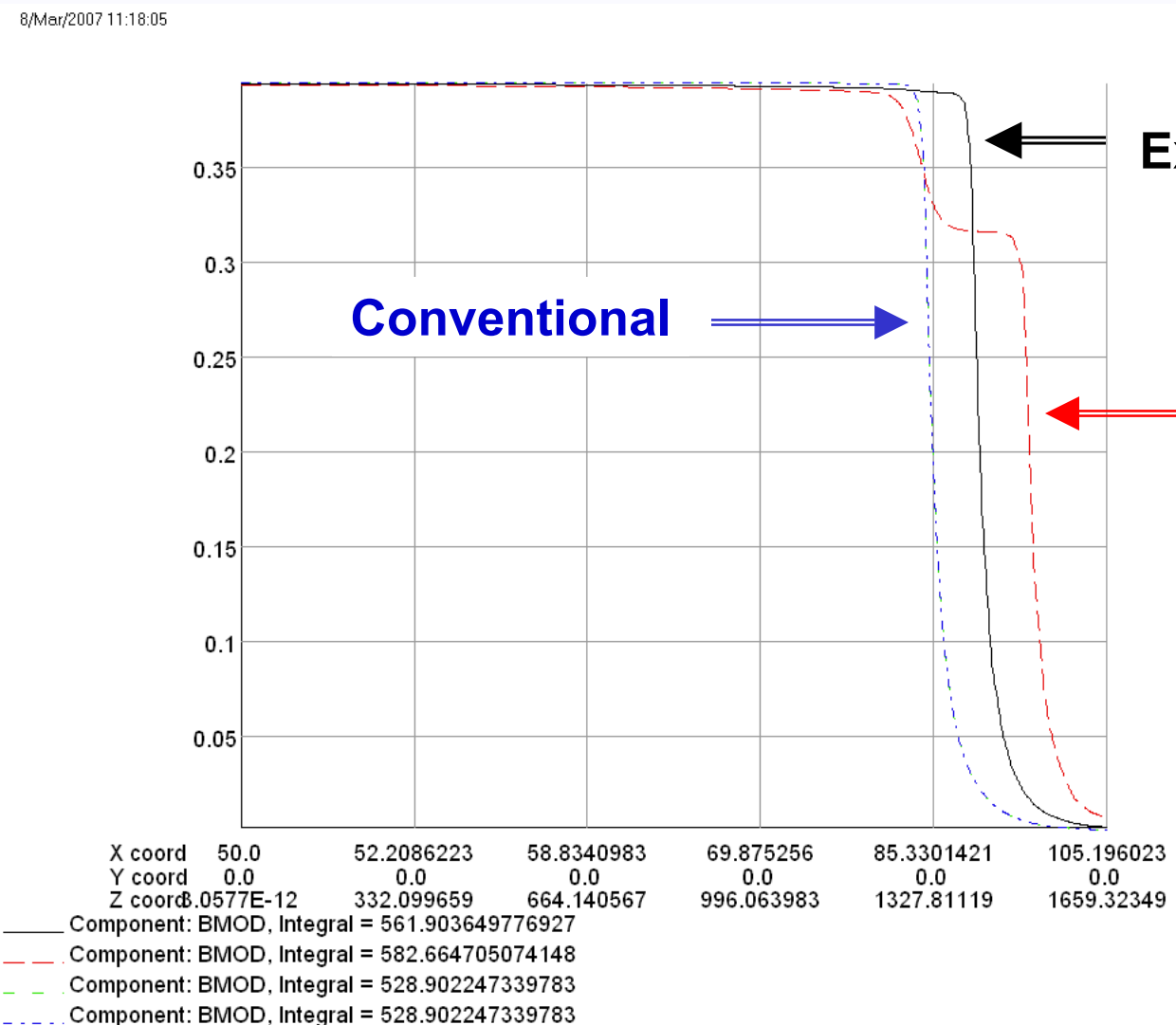


Extended Pole



Too Greedy

Space Savings by Extending Pole

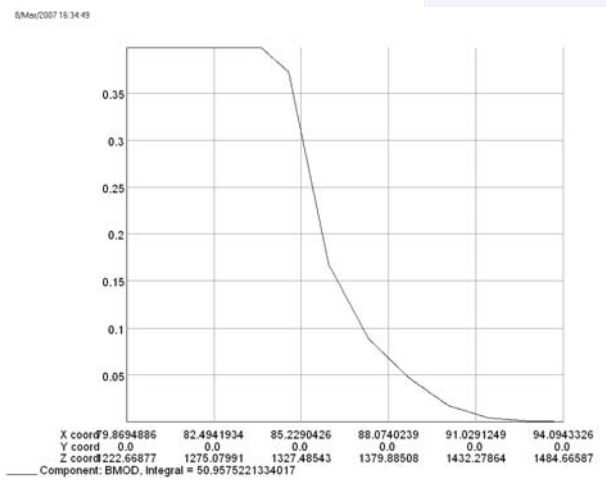


UNITS

Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Mean Scalar Pot	A

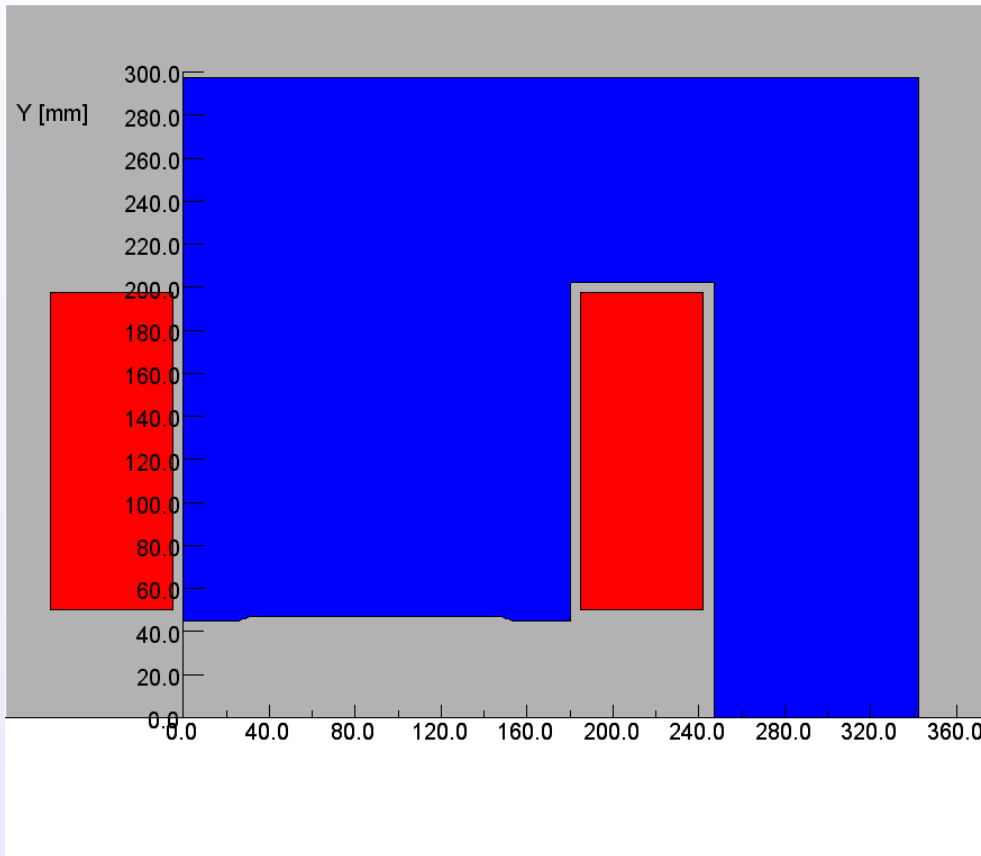
Conductivity S mm⁻¹
Current Density A mm⁻²
Power W
Force N
Energy J

PROBLEM DATA
Is2-cu4-35mm-no-tooth.op3
TOSCA Magnetostatic



Field fall off in conventional case (scale adjusted for more details)

Status of 90 mm Dipole Work



Work under progress

- Good field quality (2d) obtained.
- Even though this magnet has higher physical aperture, good field aperture requirements are assumed to be the same as in 35 mm aperture dipole.

Important issue:

- Match power supplies
- Minimize end space (more in larger aperture dipoles)

Summary

- **Coil ends have been examined**

(including some interesting variations in the base line design).

- **Significant space can be released.**

This design study, if desired, will need some guidance.

- **Next higher priority NSLS2 tasks:**

- **90 mm aperture dipole**
- **Combine 3-d design of 3 pole wiggler and dipole**
- **Optimum positioning of the 3-pole wiggler (including space minimization)**